

The field data collected throughout the season 2022: AREI Stende Research Centre

NOBALwheat project meeting, 03.11.2022



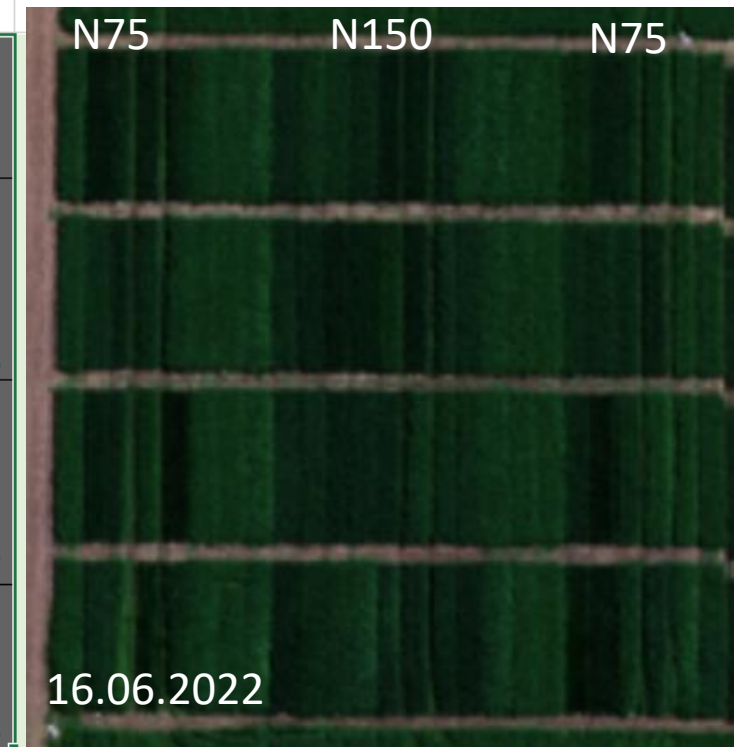
Soil and agrotechnical measures, 2022

Agrotechnical measures	WP1		WP4
Soil characteristics	Block 1: GEN300	Block 2: DIS300	Block 3: NUE trial (N75; N150)
Soil type	sod podzolic, clay sand	sod podzolic, clay sand	sod podzolic, clay sand/sand
pH _{KCL}	6.05		5.52
P ₂ O ₅ , mg kg ⁻¹	287.3		245.1
K ₂ O, mg kg ⁻¹	162.6		151.3
N, % / NH ₄ , mg L ⁻¹ / NO ₃ mg L ⁻¹	0.69 / 171 / 3.86		1.04 / 215 / 2.40
Humus content, %	2.04		1.72
Pre-crop	red clover	red clover	red clover
Sowing date	23.04.2022	23.04.2022	23.04.2022
Fertilization	N120N75P75S66: NPKS 15-15-15-11, 500 kg ha ⁻¹ ; NS 30-7, 150 kg ha ⁻¹ ; 22.04.2022		N75N75P75S55 NPKS 15-15-15-11, 500 kg ha ⁻¹ ; 22.04.2022 N150N75P75S55 NPKS 15-15-15-11, 500 kg ha ⁻¹ ; 22.04.2022; Amonium nitrate NH ₄ NO ₃ (N33.5) 224 kg ha ⁻¹ 23.05.2022
Herbicide	Sekator (amidosulfurons 100 g/l, nātrija metiljodosulfurons 25 g/l) 0.5 L ha ⁻¹ ; Estet (600 g/l 2,4-D, (905 g/l 2,4-D 2-etilheksilester) 0.5 L ha ⁻¹ ; 06.06.2022		
Fungicide	1 x: Falkon Forte protiokonazols - 53 g/l; spiroksamīns - 224 g/l; tebukonazols - 148 g/l) 0.7 L ha ⁻¹ ; (GS31-32); 17.06.2022; 2 x: Elatus Era 0.75 L ha ⁻¹ GS 51. 27.06.2022		
Harvesting date	24.-25.08.2022	x	24.08.2022

NUE trial design, 2022

split plot design - field is divided into four main blocks and the application of the two N fertilization levels randomized among those four

	N75					N150						N75									
	Randomized					Randomized						Randomized									
4	5	12	13	20	21	28	29	36	37	44	45	52	53	60	61	68	69	76	77	84	85
3	6	11	14	19	22	27	30	35	38	43	46	51	54	59	62	67	70	75	78	83	86
2	7	10	15	18	23	26	31	34	39	42	47	50	55	58	63	66	71	74	79	82	87
1	8	9	16	17	24	25	32	33	40	41	48	49	56	57	64	65	72	73	80	81	88



Seeding rate

TRIAL	Amount of germinable seeds, 1 m²	Sowing plot area, m²	Harvested plot area, m²
WP1 / GEN300	500	5.5	5.0
WP1 / DIS300	500	1.0	-
WP4 / NUE trial	500	10.3	10.0

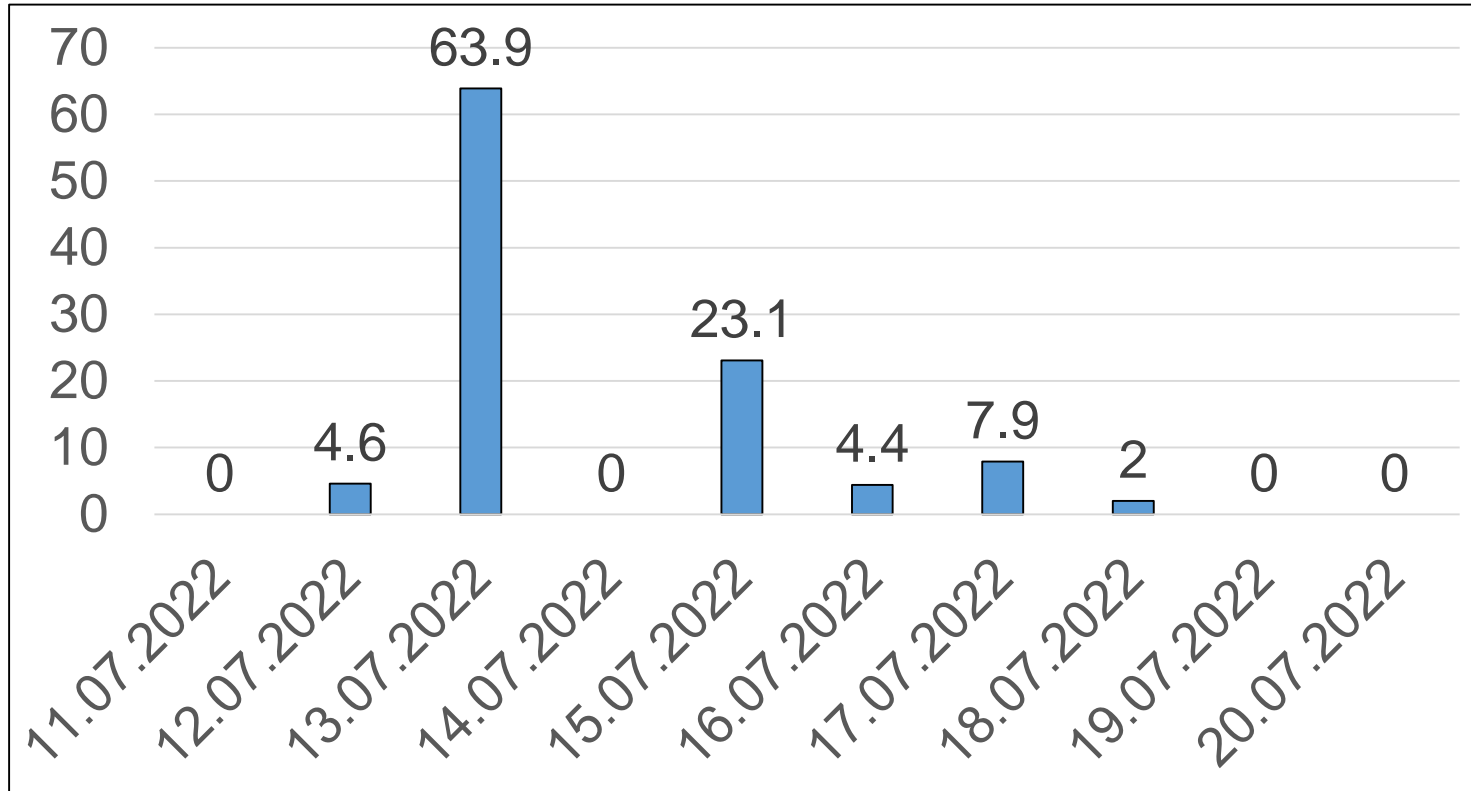


Characteristic of meteorological conditions, Stende, 2022

Month	Average air temperature, C°					
	I	II	III	Average	long-term average	± long-term average
April	1.6	5.4	6.4	4.5	5.8	-1.3
May	7.7	9.9	10.9	9.5	11.1	-1.6
June	14.4	15.1	20.5	16.7	14.7	2.0
July	17.7	16.0	17.3	17.0	17.3	-0.3
August	17.6	21.8	19.0	19.5	16.6	2.9

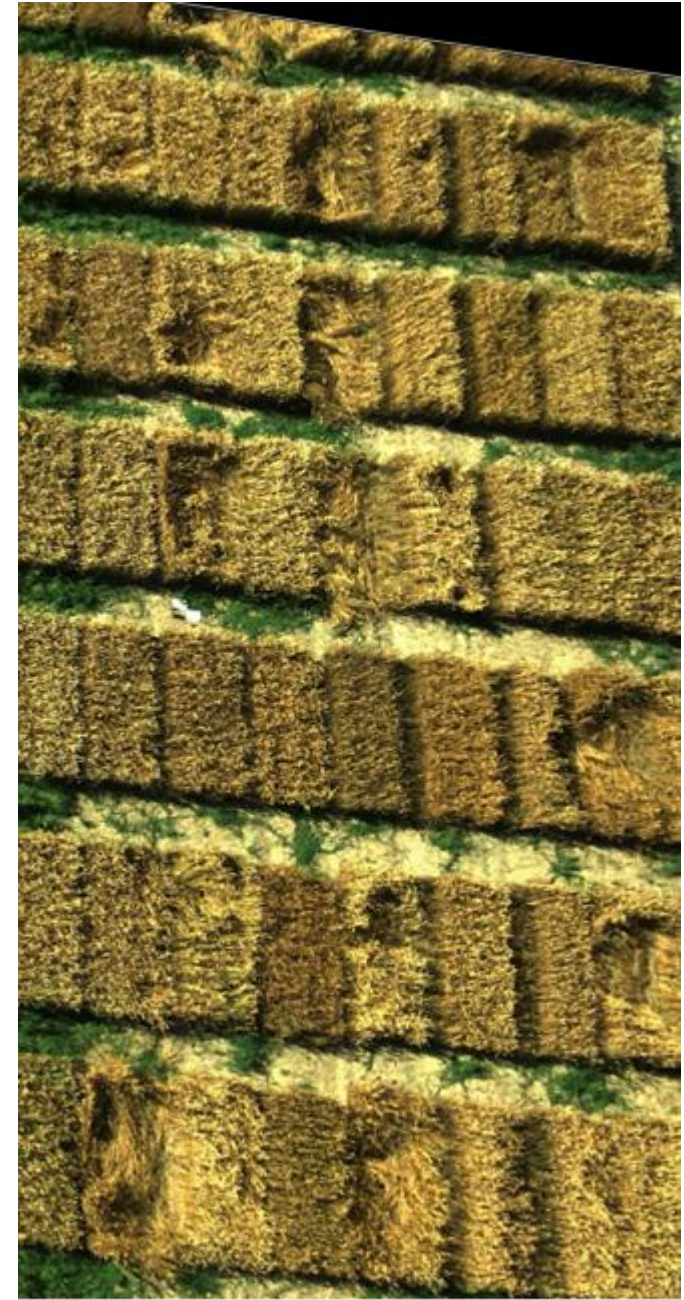
Month	Sum of precipitation, mm					
	I	II	III	Sum	long-term average	from long-term, %
April	33.1	4.1	2.9	40.1	38.1	105
May	1	11	30	42	46	91
June	38.3	6.1	3.8	48.2	71.4	68
July	34.6	105.9	18.7	159.2	78.1	204
August	11.1	1	70.7	82.8	83.4	99

Sum of precipitation (mm), the 2nd decade of July, 2022



In July 105 mm, 204% from long term average data

- early lodging from middle of July: odging N75=7.7; N150=6.8
- promoted fast development of powdery mildew



WP1 DIS300 trial

✓ Powdery mildew 3 times:

2022.06.28; 2021.07.13; 2022.07.20

✓ Septoria leaf blotch 2 times:

2022.07.14; 2022.07.21

Yellow rust 1 time:

2022.07.14

Leaf rust 1 time:

2022.07.14

✓ Septoria nodorum 2 times:

2022.07.21; 2022.08.03





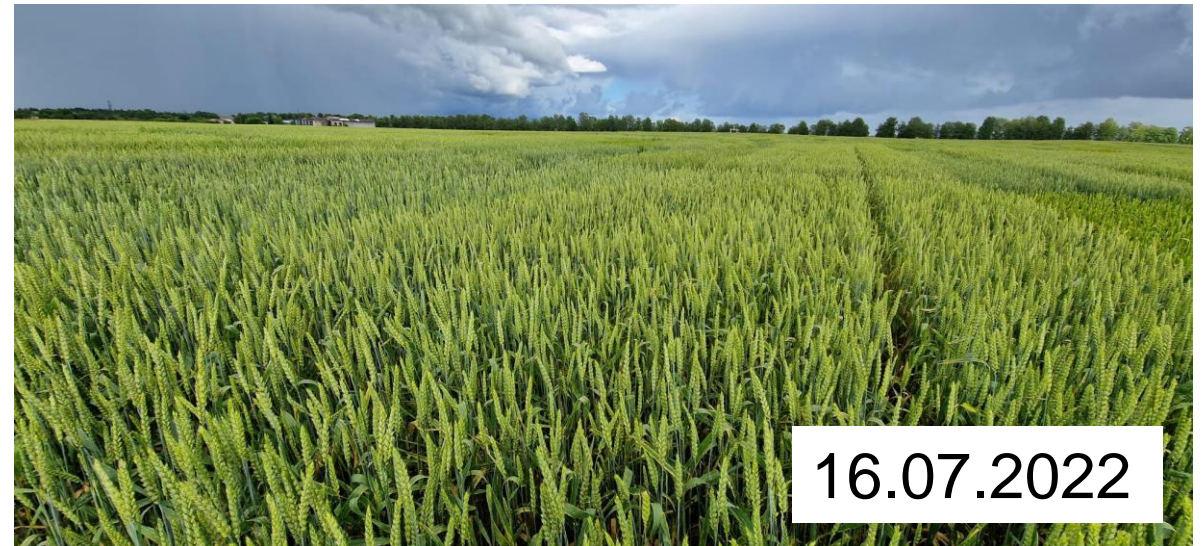
21.05.2022



03.06.2022



16.06.2022

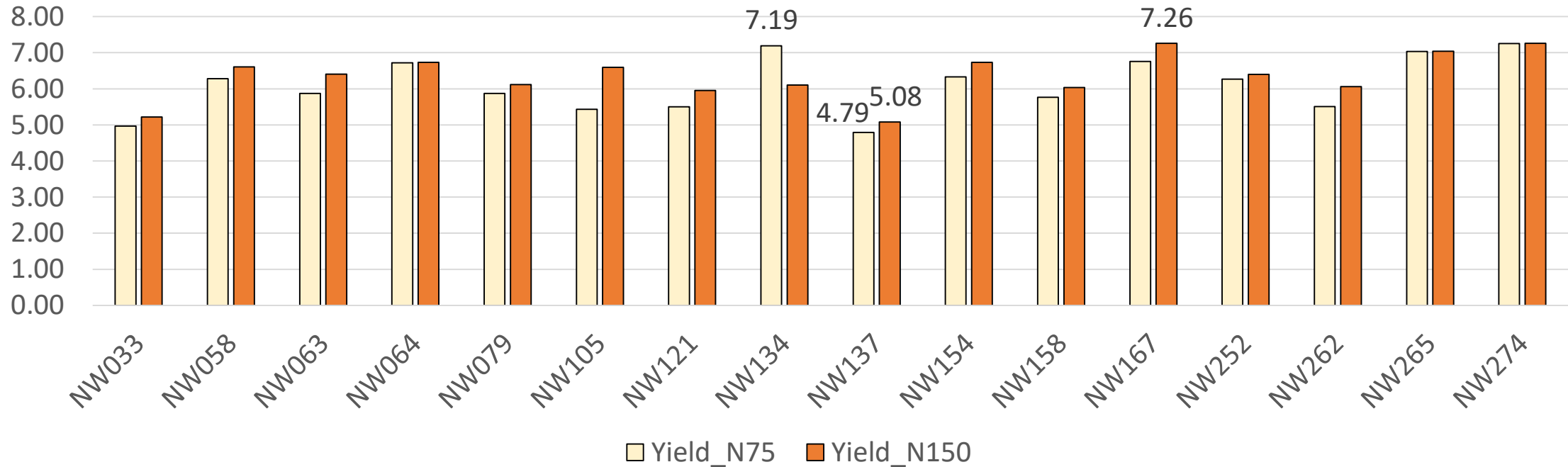


16.07.2022

NUE trial: grain yield and grain quality

Trait	N75	N150	<i>p-value</i>		
			Genotype	N level	Interraction
Grain yield, g m²	609.51b	634.99a	0.000	0.023	0.367
1000 kernel weight, g	38.80a	37.39b	0.000	0.006	0.801
Test weight, kgh	79.83a	78.81b	0.001	0.008	0.844
Protein, %	13.77b	15.18a	0.000	0.000	0.075
Gluten content, %	29.62b	33.18a	0.000	0.000	0.086
Starch content, %	67.31a	65.82b	0.000	0.000	0.067
Sedementation index	49.94b	61.18a	0.000	0.000	0.070

NUE trial: Grain yield variation



ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Genotype	260756.8	15	17383.79	9.501534	6.54E-08	1.99199
Nitrogen	10387.48	1	10387.48	5.677533	0.023292	4.149097
G x N	31165.12	15	2077.675	1.135604	0.366956	1.99199
Within	58546.45	32	1829.577			
Total	360855.9	63				

Work done up to now

- ✓ **GEN300:** field data collection is completed; yield data for one replication
- ✓ **NUE:** data templates are completed

Work still has to be done

- ✓ **GEN300:** finalizing field data templates; yield data, grain quality assessment
- ✓ **NUE trial:** morphology traits and total N analysis for above-ground plant biomass samples

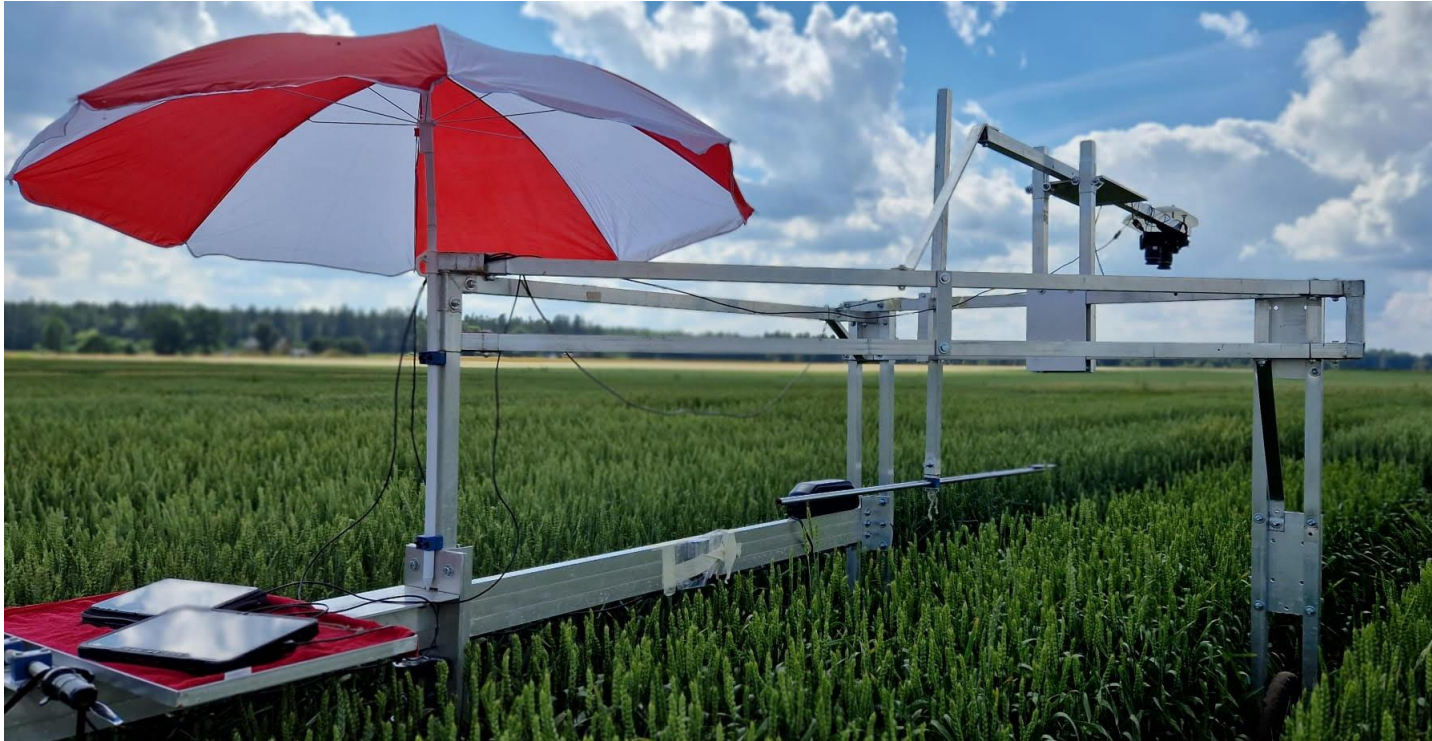
WP2; Task 2.2. Proximal phenotyping

No	Growing stages		GEN300	NUE
1	GS21	Beginning of tillering (main shoot and 1 tillering)	26.05.2022	
2	GS65	Full flowering: 50% of anthers mature	NIR 30.06.2022 RGB 01.07.2022	
3	GS73	Early milk	19.07.2022	



NW300 trial 26.05.2022: Beginning of tillering

Phenomobile functional improvements





19.07.2022: Early milk

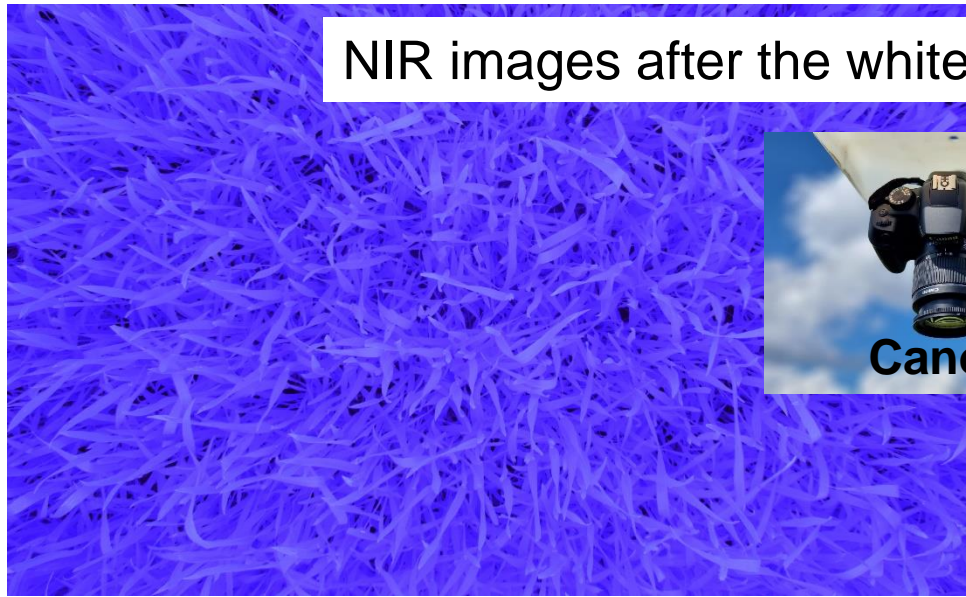
NDVI imaging GS65, 30.06.2022

Converted camera Canon EOS 1300D for NDVI imaging by using ordered filters (NDVI Blue IR filter (Blue +IR) from **Kolari Vision**)

- the NIR signal is mapped to the blue channel
- classic formula $NDVI = (NIR - RED) / (NIR + RED)$

Converted camera Canon EOS 1300D for NDVI imaging from **LifePixel**

- the NIR signal is mapped to the red channel
- Applied formula $NDVI = ((NIR + Green) - (2 \times Blue)) / ((NIR + Green) + (2 \times Blue))$



NIR images after the white balance corrections and cropping



NW158_N150_R2_NIR_AREI_LV_30.06.2022

NW158_N150_R2_NIR_SLU_30.06.2022

NDVI imaging GS65, 30.06.2022

Growing stages	GEN300 trial	NUE trial	NDVI Camera
GS21	26.05.2022		<i>Colari Vision</i>
GS65	30.06.2022		<i>Colari Vision LifePixel</i>
GS73	17.07.2022		<i>Life Pixel</i>

$$r_{N75=Colari\ vision/LifePixel} = -0.064$$

$$r_{N150=Colari\ vision/LifePixel} = -0.179$$

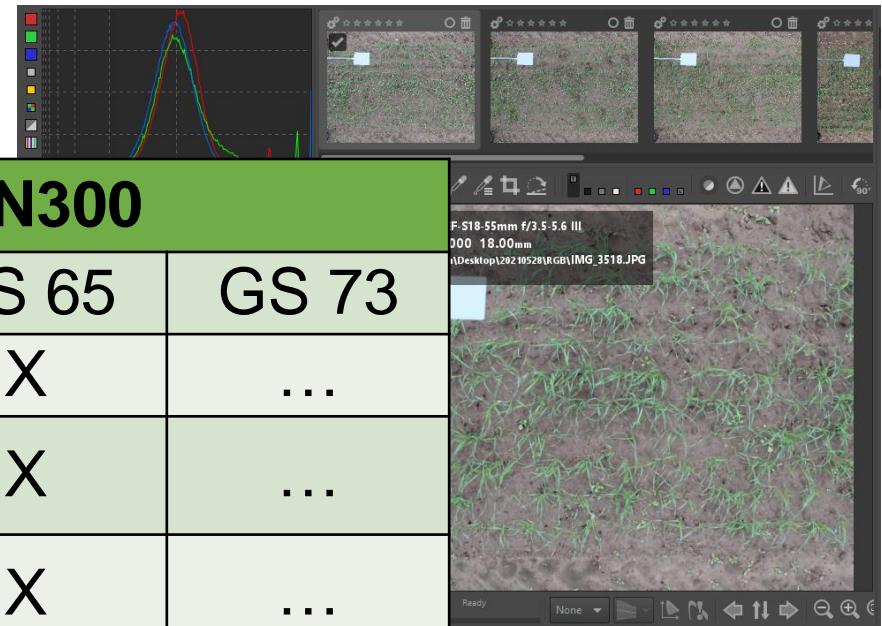
Genotype	<i>Colari Vision NDVI</i>		<i>LifePixel NDVI</i>	
	N75	N150	N75	N150
NW033	0.48	0.45	0.70	0.69
NW058	0.50	0.47	0.70	0.70
NW063	0.50	0.49	0.75	0.73
NW064	0.49	0.50	0.69	0.68
NW079	0.45	0.47	0.70	0.69
NW105	0.51	0.49	0.68	0.70
NW121	0.47	0.45	0.67	0.68
NW134	0.43	0.45	0.69	0.70
NW137	0.51	0.53	0.69	0.69
NW154	0.50	0.48	0.74	0.72
NW158	0.39	0.46	0.76	0.74
NW167	0.45	0.49	0.70	0.70
NW252	0.49	0.50	0.66	0.67
NW262	0.45	0.45	0.72	0.75
NW265	0.48	0.44	0.73	0.74
NW274	0.40	0.43	0.71	0.69
Average	0.47	0.47	0.70	0.70
p-value	0.082	0.692	0.235	0.015

NUE trial: correlation between yield and protein, and vegetation indices

Traits	Yield_N75
Protein_N75	-0.556
N75_NDVI_LifePixe_01.07	0.107
N75_NDVI_LifePixe_19.07	0.262
N75_GA_01.07	0.180
N75_GGA_01.07	0.259
N75_GA_19.07	0.322
N75_GGA_19.07	0.263

Traits	Yield_N150
Protein_N150	-0.335
N150_NDVI_LifePixel_01.07	0.169
N150_NDVI_LifePixel_19.07	0.108
N150_GA_01.07	0.241
N150_GGA_01.07	0.132
N150_GA_19.07	0.325
N150_GGA_19.07	0.289

Task 2.2. Work done up to now



Vegetation indexes	NUE (N75; N150)			GEN300		
	GS 21	GS 65	GS 73	GS 21	GS 65	GS 73
Breedpix*	X	X	X	X	X	...
NGRDI/TGI	X	X	X	X	X	...
Early Vigor	X	X	X	X	X	...
Ear Counting	NA	NA	X	NA	NA	...
NDVI	X	X X	X	(X...)	(X....) X	(X...)

* Breedpix - Intensity, Hue, Saturation, Lightness, a, b, u, v, GA, GGA, CSI.

X Colari Vision camera

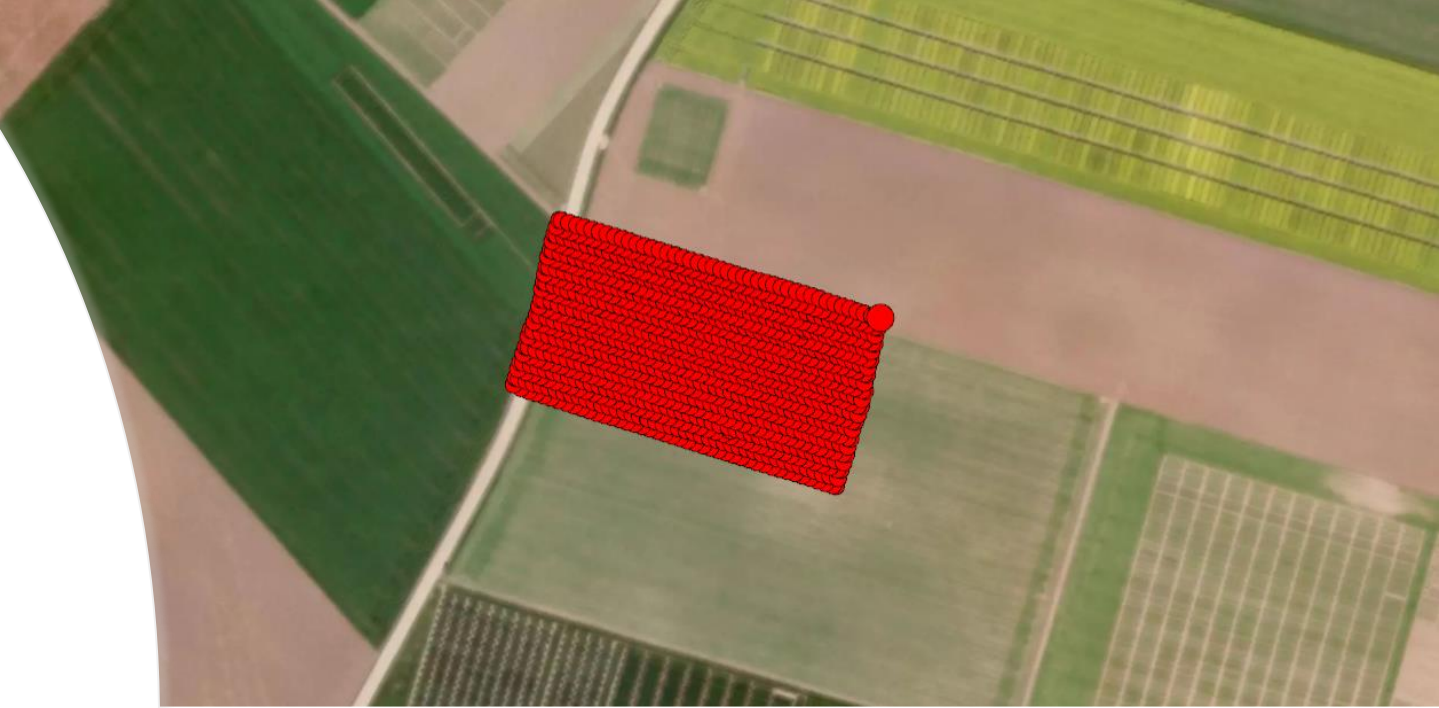
X LifePixel camera

(X....) work still has to be done

UAV data collection

NOBAL wheat 2nd season

Location and field



Task 2.1. Starting second season

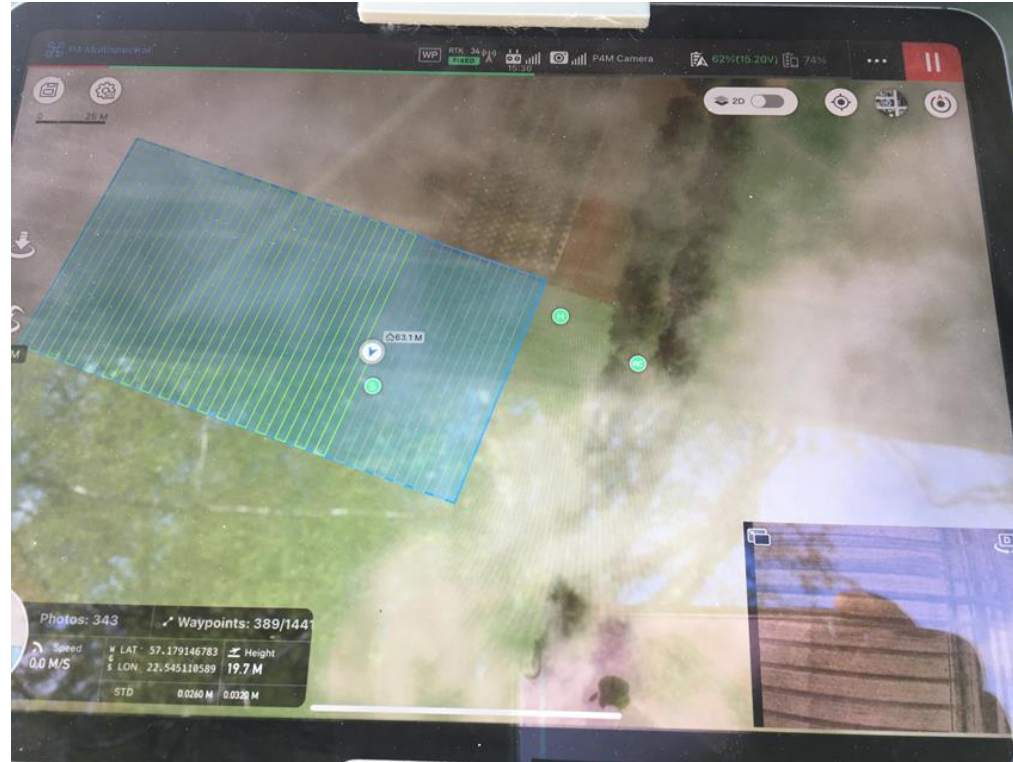
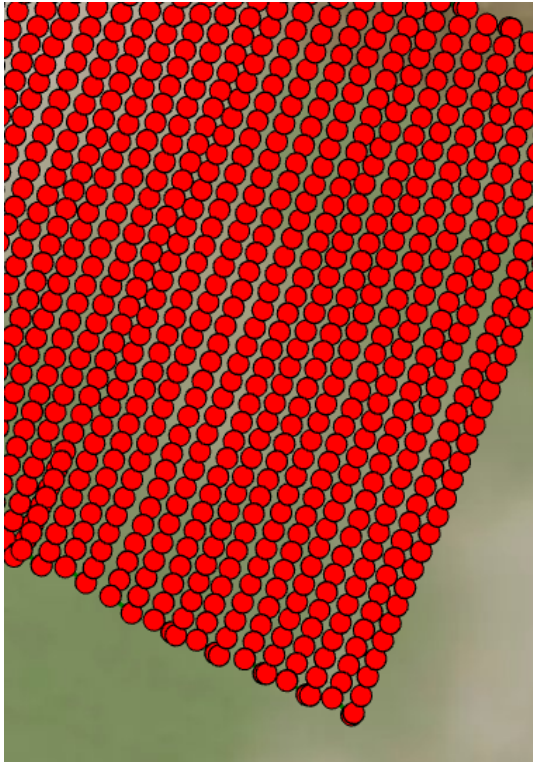
10-May-2021

vs

03-May-2022



Flight schedule and plans



- 01-03-May
- 02-10-May
- 03-18-May
- 04-25-May
- 05-04-Jun
- 06-16-Jun
- 07-22-Jun
- 08-30-Jun
- 09-18-Jul
- 10-22-Jul
- 11-03-Aug
- 12-12-Aug
- 13-23-Aug

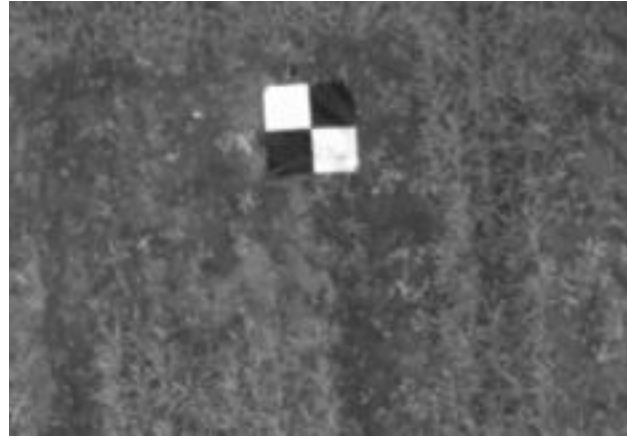


What is done?

- 13 field expeditions, approx. 480 GB of data
- 730 Gb all together with postprocessed data (not all yet)
- NDVI, orthophoto of all bands (quick tests)
- Point clouds (quick tests)
- Processing software Pix4D Mapper
- GIS software QGIS
- Using good workstation for data processing

Resources, tools, security

- P4 Multispectral, 6 batteries
- iPad
- Laptop
- External disks
- SD cards
- Calibration panel
- Field marks
- Takeoff and landing platform
- Field office
- Backup storage





Difficulties and challenges

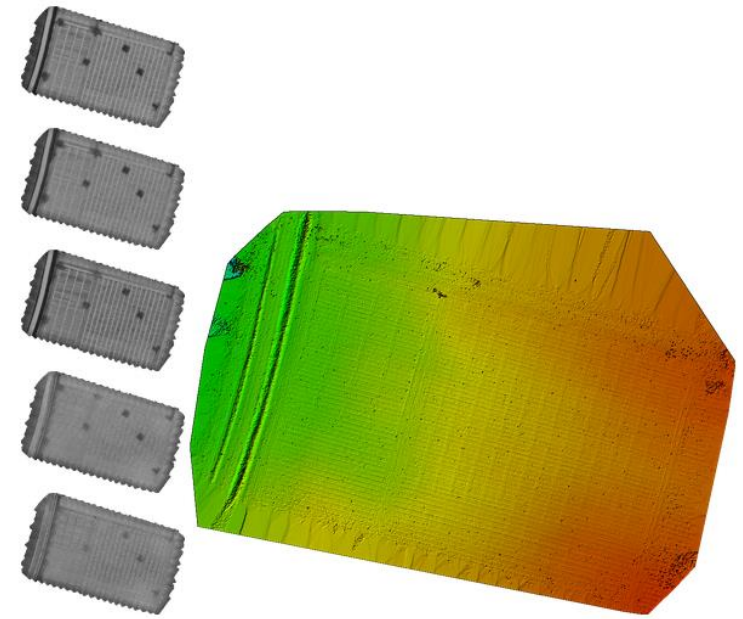
- Weather conditions
- High wind was always
- Malfunction of drone (RTK)

Postprocessed results

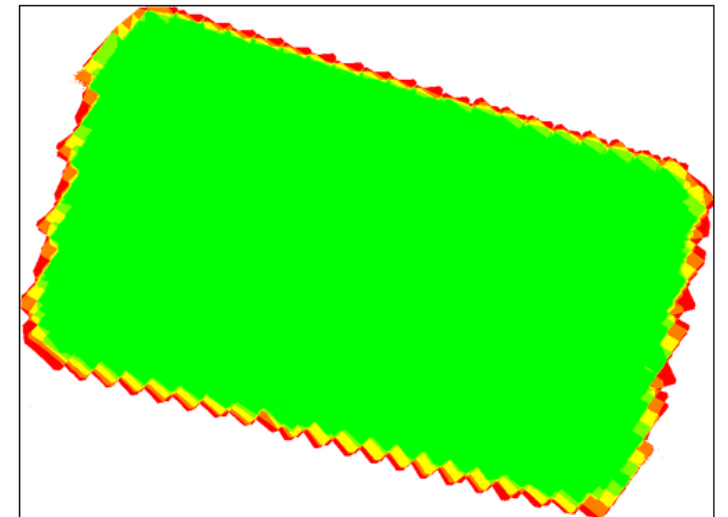
- Orthophoto for each band
- NDVI
- 3D Point cloud
- Accuracy
- Defects
- Quality report

Quality of flights and picture coverage is improved

Preview



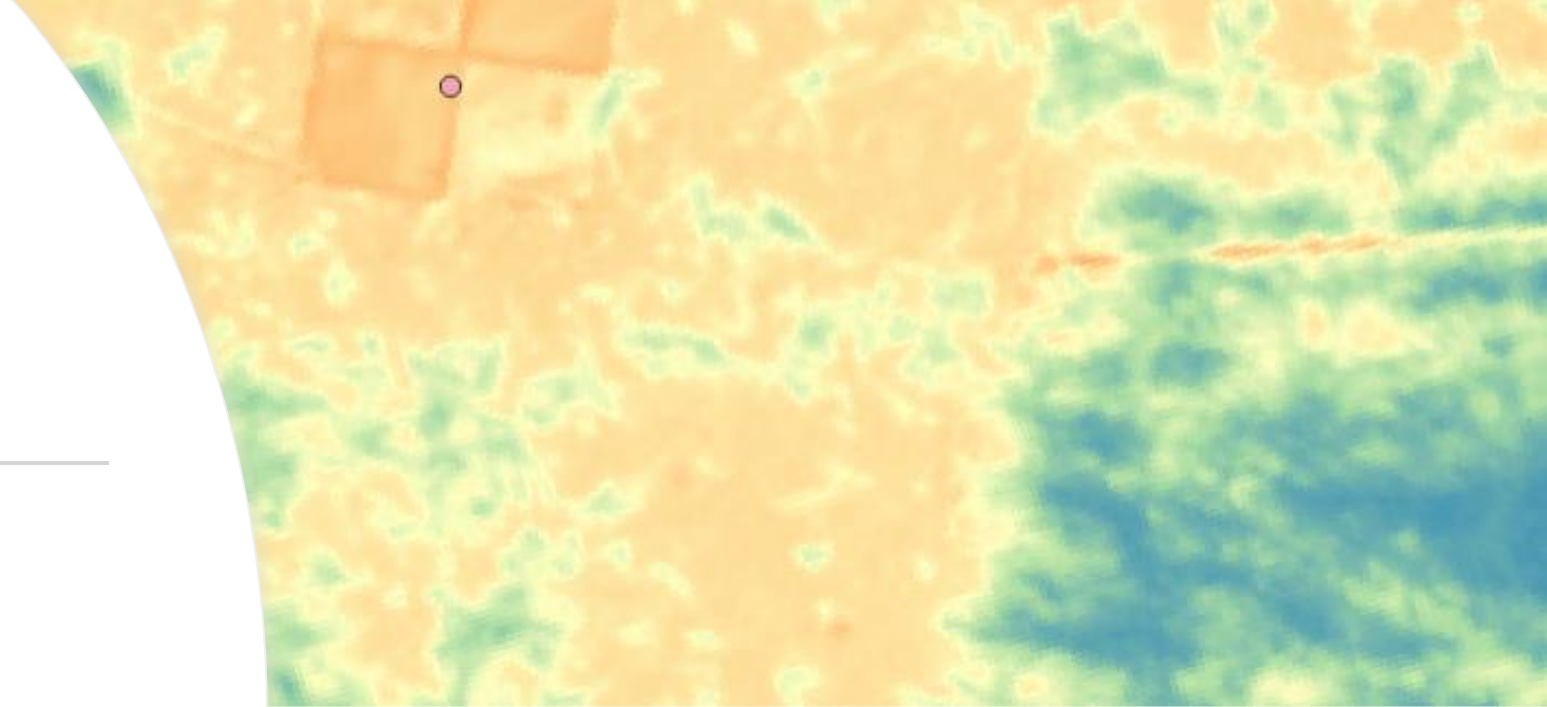
Overlap



Number of overlapping images: 1 2 3 4 5+

GCP and accuracy

- 25 May, average error 1-3 cm
- When RTK working well

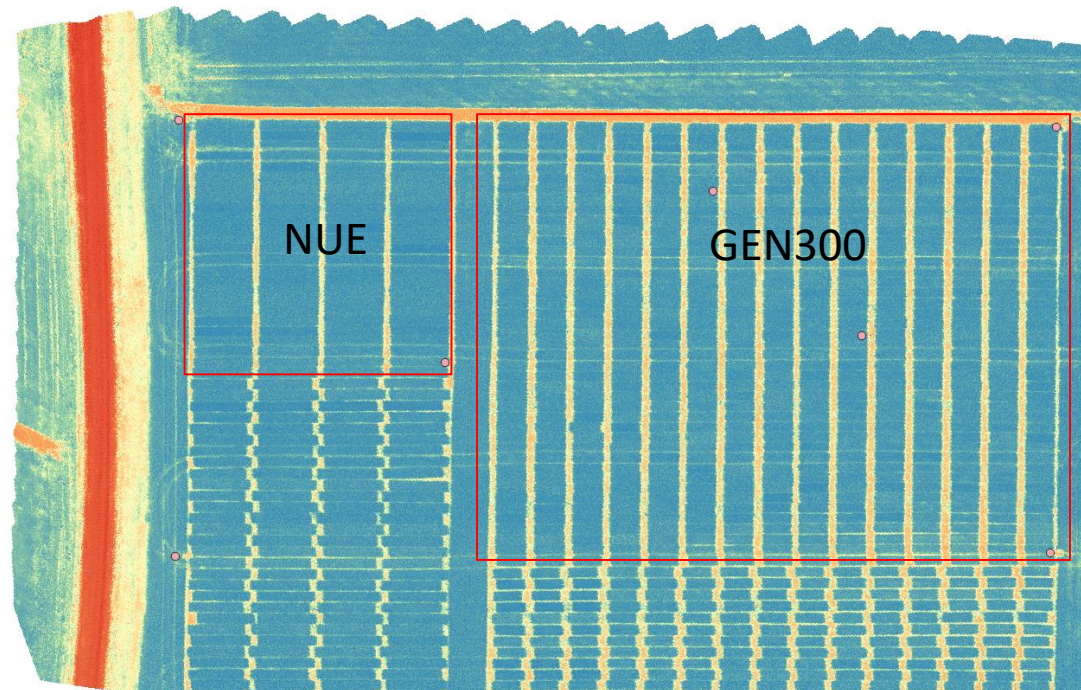
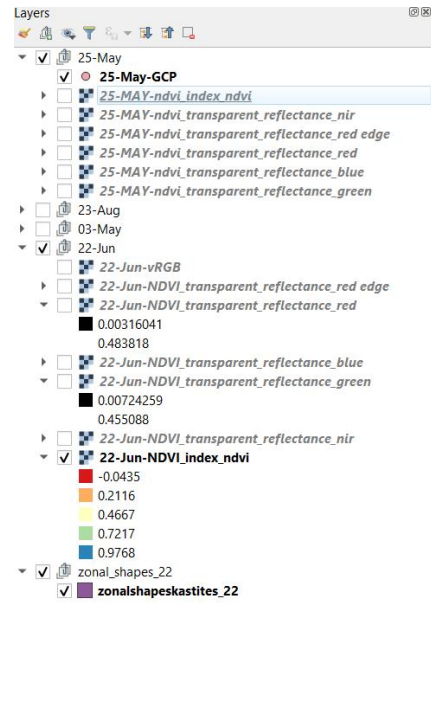
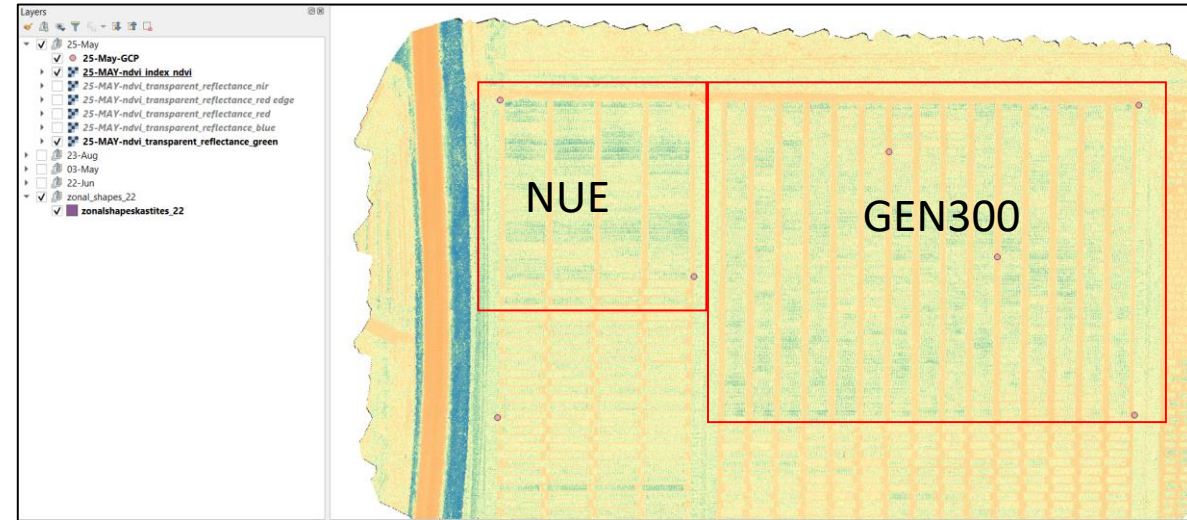


Use of DJI D-RTK mobile base station

- Coordinates precision for individual flights for each picture around 4 cm
- Shifting between flights from 50cm to 1.5 meter, still have to use GCP markers and georeferencing tools



Some results



Thank you for good knowledge



NOVA
UNIVERSITY NETWORK

COURSE COMPLETION CERTIFICATE

This certificate is awarded to

Andris Lapans

For successfully completing the course:

NOVA-412: High throughput field phenotyping

Summer 2022, Norwegian University of Life Sciences, Ås, Norway

Course contents:

- Field phenotyping methodologies
- Practical training in use of hand-held sensors and UAV imaging
- Data processing of UAV images from field trials
- Statistical data analysis of phenotyping data from field trials

Nominal workload:

- 25 hours seminars, workshops and exercises
- 15 hours lectures
- 85 hours independent work (home assignments)

Total: 125 hours

ECTS: 5



Course Leader: **Morten Lillemo**

Professor in Plant Breeding
Department of Plant Sciences
Norwegian University of Life Sciences



Norwegian University
of Life Sciences

An aerial photograph showing a large, flat landscape. In the center, there is a green golf course with several sand traps. Surrounding the golf course are large, rectangular agricultural fields, some of which are brown and appear to be recently plowed, while others are green. A paved road runs horizontally across the bottom of the frame, with a dark-colored car parked on the left side. The background features a line of trees and a clear blue sky. The text "Questions ?" is overlaid in the center of the image in a white, sans-serif font.

Questions ?